APPENDIX:

Example Research and Development Technology Transfer Case Studies and Enabling Policy Environment Programs

EXAMPLE RESEARCH AND DEVELOPMENT TECHNOLOGY TRANSFER CASE STUDIES

Chevron Texaco Gulf of Mexico Gas Hydrates Joint Industry Project (JIP)

Funding: US$3,018,000
Objective: To develop technology and data that will help in characterizing naturally occurring gas hydrates in the deepwater Gulf of Mexico.
Duration: 2001–2003

Summary

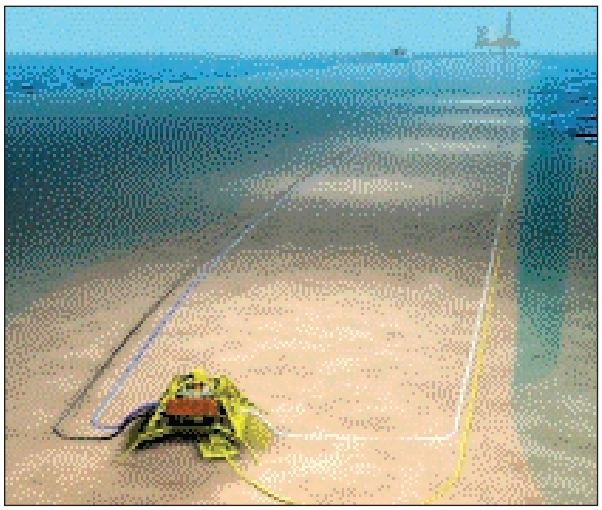
Methane hydrate is believed to be ubiquitous to the shallow marine sediments of deepwater continental shelves around the globe. Sizeable accumulations are known to exist offshore in Japan, India, Africa, and the United States (US). The project will provide information for technological solutions to seafloor failure and the uncontrolled release of large quantities of methane from hydrates during exploration and production activities.

Financing

Of the US$3,018,000 in funding, roughly half comes from the US Department of Energy (USDOE) Strategic Center for Natural Gas (SCNG) within the National Energy Technology Laboratory (NETL). The remainder comes from the private-sector Chevron Petroleum Technology Company.

The Project

Information generated under this project will provide a better understanding of how natural gas hydrates can affect seafloor stability, provide data that can be used by scientists in their studies of climate change, and provide data to assess if and how gas hydrates act as a trapping mechanism for shallow oil or gas reservoirs.



The project is a two-phased study designed to drill for naturally occurring gas hydrates in the Gulf of Mexico at water depths of 1,000 ft or more. Phase I includes data collection and analysis and model development obtained through workshops. Findings will be compiled in a database. Phase II will be a drilling and sampling program. On the basis of Phase I findings, Chevron Texaco will devise a strategy to drill through and recover cores for further analysis from known hydrate accumulations.

Initial efforts focus on safety issues, characterizing natural methane hydrate, and uncovering its connections to the global environment. As pressing environmental and safety issues are resolved, the program will shift toward safely producing methane from hydrates. Work on production technologies is underway. In the near term, understanding the role of methane hydrates in seafloor and slope stability is important in developing effective safety measures in deepwater petroleum exploration and production activities. In the long term, the ability to identify unstable regions of the seafloor and take effective measures to mediate problems will result in fewer hazards and will reduce risks, costs, time, and labor.

In addition to causing slope failure on the seafloor, the large amount of gas that may be released upon disturbing the hydrate zone may have a dramatic effect on climate. The project will supply data to understand cause-and-effect relationships and to provide information for technological solutions to reduce these risks.

Sustainable Development Potential of the Project

The data and information on seafloor stability, climatic effects, and reservoirs beneath hydrate zones will guide the development of safety measures to address the risks. Avoiding unforeseen and unexpected hazards is key to a secure and affordable energy supply until such time that sustainable and renewable energy sources become feasible. The project will help support sustained economic growth by reducing risks and costs, thus adding security and additional price stability to energy supplies.

Technical Data

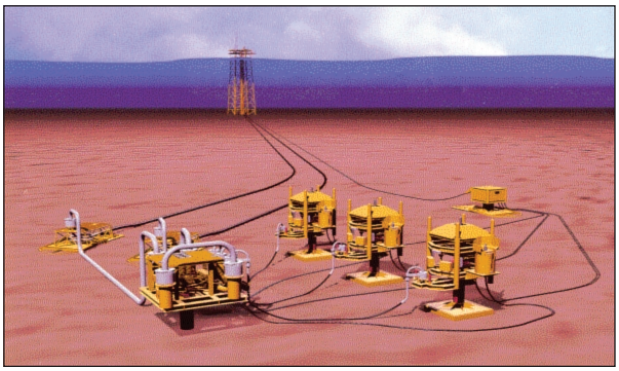
Technologies used in the project include specially tailored geophysical and geochemical techniques for hydrate appraisal. New production technologies that safely promote the in-situ dissociation of methane from hydrate are also being developed.

Technology Transfer Potential

The data and information gathered during the project can be used to mitigate hazards from seafloor instabilities in exploration and production activities in marine environments around the world. Understanding the role of hydrates in climate will help in assessing the risks for various regions if, or when, the production of methane from hydrates becomes feasible.

Participants and Roles

The USDOE's NETL is the primary funding organization. Members of the Joint Industry Project are Chevron Texaco, Conoco, Halliburton, Minerals Management Service, Phillips Petroleum Company, Schlumberger, and TotalFinaElf.



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Wabash River Coal Gasification Repowering Project/ Clean Coal Technology Demonstration Program

Funding: US$468,000,000
Objective: To demonstrate the use of a new coal gasification process to repower a pulverized coal-fired boiler.
Duration: 1992–1995

Summary

The Wabash River Coal Gasification Repowering Demonstration Project demonstrated an environmentally superior method of generating electricity from coal. This method, integrated gasification combined-cycle (IGCC), in general, and the E-Gas Technology™, specifically, can produce a syngas stream that can be used to manufacture alternate transportation fuels such as liquid methanol, which could be beneficial in developing countries.

Financing

Of the US$468,000,000 in funding, US$219,000,000 was from the United States Department of Energy (USDOE). Private-sector contributions included US$181,000,000 from Destec Energy Gasification Business Unit (which was acquired by Global Energy in 1999) and US$68,000,000 from PSI Energy. Of the USDOE funding, US$168,000,000 was for capital costs, with the balance for the four-year operational demonstration phase. The Global Energy and PSI Energy contributions funded the remaining capital costs of the project.

The Project

The project is part of the Clean Coal Technology (CCT) Demonstration Program, a government-industry cooperative model established in 1985 to provide utilities and major coal-using industries with options for reducing environmental impacts of using coal and generating electricity at lower cost. The CCT Demonstration Program has helped commercialize technologies that reduce emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter, mercury, and other air toxics from coal-fired boilers.

The Wabash project demonstrated the use of the E-Gas Technology to repower a pulverized coal-fired boiler using an integrated gasification combined-cycle (IGCC) system. It provided advancements in the E-Gas Technology relevant to the use of high-sulfur bituminous coal (or petroleum coke) and data to assess the long-term reliability, availability, and maintainability of the system at the commercial scale. Industrial,

commercial, and residential sectors benefit from the improved environment and availability of cost-competitive electricity.

The project reduced SO_2 emissions by 99% (as low as 0.03 lb SO_2/million Btu) and controlled NO_x emissions to 0.10 lb/million Btu. Particulate emissions from the project are also very low (0.01 lb/million Btu). These levels meet and exceed all existing US environmental regulations. The improved efficiency of this technology relative to conventional pulverized-coal combustion techniques results in a decrease of carbon dioxide (CO_2) emissions, which could potentially impact long-term climate changes.

Even when operating on relatively high-sulfur coals, the Wabash River project is the cleanest coal-fired power plant in the world of any technology. In addition to its very low air emissions, the project produces no solid wastes and only two by-products: sulfur and slag. The sulfur produced by cleaning the syngas is sold as 99.99% pure elemental sulfur, while the slag (the coal ash component) is marketed for use in asphalt mixes and as a construction material.

Sustainable Development Potential of the Project

The project demonstrated SO_2 reductions of 99% and limited NO_x emissions to 0.10 lb/million Btu. Economic growth is assisted by allowing the use of cheap and abundant coal to generate electricity in place of more expensive alternatives. Generating reasonably priced electricity for rural areas helps provide for basic human necessities and raises the standard of living, thereby contributing to social development.

Technical Data

The E-Gas Technology is a coal gasification process that utilizes a two-stage pressurized, oxygen-blown, entrained-flow gasifier. The remainder of the system consists of a syngas cooler, hot/dry filters for particulate removal, heat exchangers for additional syngas cooling, a water scrubber to remove chlorides, a hydrolysis catalyst bed to convert carbonyl sulfide (COS) to hydrogen sulfide (H_2S), a methyldiethanolamine-based (MDEA) absorber/stripper system for H_2S removal, a Claus unit to produce elemental sulfur, a gas turbine combined-cycle plant that incorporated an existing 1953 steam turbine, and an air separation plant.

Technology Transfer Potential

The project upgraded an existing 100-MW conventional pulverized-coal unit with a 262-MW (net) IGCC facility. Prior to repowering, this unit operated at a 30% annual capacity factor. At a 75% capacity factor, the repowered

IGCC not only makes 5.6 times more electrical power annually, but it does so while still reducing emissions: 5,500 tons per year less SO_2, 1,179 tons per year less NO_x, and 100 tons per year less particulate emissions.

The E-Gas Technology can be located on a greenfield site, or it can be used to repower an existing facility. Application of the technology results in the production of electricity, a wide range of chemical products from the gasifier-generated syngas (such as alternate transportation fuels), or both. The technology capacity range is nominally 250 to 1,000 MW(e).

Participants and Roles

USDOE cofunded the project and provided oversight. Global Energy, Inc., was a cofunder and provided the gas turbine technology. PSI Energy was a cofunder and provided the combined-cycle plant.

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Restoring Coastal Wetlands Using Drill Cuttings

Funding: US$300,000
Objective: To assess the feasibility of using waste cuttings from oil and gas drilling for restoring wetlands.
Duration: 1998–present

Summary

Using cuttings that result from oil and gas drilling activities can provide an environmentally beneficial and cost-effective waste management strategy for drilling wastes. These large-volume wastes can be used to help restore impaired or lost wetlands. The program has applicability for wells drilled in or near environmentally sensitive wetlands environments around the world.

Financing

Of the US$300,000 in funding, US$250,000 was from the United States Department of Energy (USDOE). M-I Drilling Fluids, a private company, contributed in-kind support estimated at US$50,000.

The Project

The USDOE has sponsored a series of projects to investigate the feasibility of using treated drilling wastes as a solid substrate for growing wetlands vegetation and restoring wetlands. The original project consisted of laboratory mesocosm studies by Southeastern Louisiana University (SLU) on freshwater wetland vegetation in a greenhouse research facility, followed by a proposed field demonstration. These studies showed that one of the two methods used to treat the drilling wastes produced a substrate that effectively grew some species of freshwater wetland vegetation to an extent comparable to that of dredged sediments. Because of difficulties in obtaining regulatory permission to demonstrate the process in the field, the mesocosm investigations continued and incorporated the effects of increasing salinity levels and brackish and salt marsh vegetation, thereby simulating the range of conditions that may be experienced in the field. To support these studies, several improved drilling waste treatment methods are being developed by M-I, a developer, manufacturer, and marketer of drilling and completion fluids. On the basis of positive results, a second round of studies is currently underway.

The project, if successful, would benefit the oil-and-gas industry, local communities, and the environment by providing a beneficial reuse for waste materials, reducing waste management costs, and improving wetlands. Once demonstrated, the concept could be expanded to other types of non-hazardous solid waste material.

Sustainable Development Potential of the Project

The program converts a waste material into a beneficial reuse that is helping to mitigate impaired wetlands, a major environmental problem facing coastal Louisiana and other Gulf Coast states. If the concept of using drill cuttings to restore wetlands in coastal marshy locations is successful, it may be extended to restoring additional wetland acreage. The restoration program could also potentially be expanded to use other types of large-volume, low-toxicity solids.

Technical Data

The technique uses solar power to separate drilling fluids from drill cuttings. The program assumed there would be 15,000 bbl of drilling waste per well. This could restore 1.5 acres per oil or gas well. Between
10 and 100 wells are drilled annually in the Louisiana marshes. If all these drilling wastes were used for restoration, between 15 and 150 acres per year could be restored.

Technology Transfer Potential

The approach could work worldwide in areas where oil and gas drilling are occurring or near marshy areas. The resulting cuttings can be cleaned to local standards and used to restore historically damaged areas and other areas recently

disturbed by the drilling process. Before the technology can be accepted for widespread use, well-monitored field trials must show that the cuttings are a suitable growth substrate and that they do not contaminate surrounding waters. Preliminary discussions for using the wetlands restoration approach in coastal areas of Mexico and Venezuela have occurred.

Participants and Roles

The USDOE's National Petroleum Technology Office (NPTO) manages the program and provides funding. SLU conducted the mesocosm studies, and M-I's research laboratory has provided several new types of drilling fluids to increase vegetative growth. Argonne National Laboratory coordinated project efforts.

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Mallik 2002: An International Research Initiative Considering Gas Hydrates as a Potential New Energy Resource

Funding: US$25,000,000
Objective: To assess gas hydrate properties and the stability of continental gas hydrates given predicted climatic warming trends.
Duration: 2001–2002

Summary

The Mallik 2002 methane hydrate well program will provide insight into the technical challenges facing the development of natural gas hydrates as an energy supply and will increase understanding of the role of gas hydrates in global climate change. New drilling, production, and geophysical technologies tested in this project may lead to new industrial development. Detailed studies of hydrate physical behavior will provide information to help assess the potential impacts of their release on future climate change. They will also help in developing techniques to avoid or mitigate hazardous conditions posed by gas hydrates to drilling and pipeline construction.

Financing

Of the US$25,000,000 in funding, US$1,000,000 is from the United States Department of Energy (USDOE) Strategic Center for Natural Gas (SCNG) within the National Energy Technology Laboratory (NETL). The remainder comes from a variety of other government and industrial partners, including the Japan National Oil Corporation (JNOC), Germany GeoForschungsZentrum Potsdam (GFZ), Geological Survey of Canada (GSC), US Geological Survey (USGS), USDOE, India Ministry of Petroleum and Natural Gas (MOPNG), and the Canadian Petroleum Industry International Continental Drilling Program (ICDP).

The Project

A consortium with seven international partners collaborated on a research well program targeted toward producing methane from hydrates in the Mackenzie Delta of northwestern Canada. The project included the drilling of a 1,200-m-deep main production research well and two nearby scientific observation wells.

The scientific and engineering research objectives for the production research well focused on two themes: (1) assessment of the production and properties of gas hydrates, and (2) assessment of the stability of continental gas hydrates given warming trends predicted by climate change models. The researchers conducted scientific experiments to gain a better understanding of gas hydrates and to test new drilling techniques and production methods. Full-scale field experiments were conducted to monitor the physical behavior of the gas hydrate deposits in response to depressurization and thermal production stimulation. Canadian scientists are also investigating the possibility of storing carbon dioxide (CO_2) in reservoirs previously occupied by gas hydrates as an innovative way of meeting Canada's emissions-reduction objectives.

The results from the Mallik 2002 program have increased our understanding of the role of gas hydrates in global climate change and will provide insights into the technical challenges facing the development of natural gas hydrates as an energy supply. Project success may significantly augment the energy self-sufficiency of areas with extremely cold winters and those regions now dependent on others for energy supply.

Sustainable Development Potential of the Project

Natural gas is the cleanest burning conventional hydrocarbon and is likely to become a dominant energy source in the future. Well production tests in Mallik will improve understanding as to how the gas in natural hydrates can be harnessed as an energy source. The result may be increased use of clean-burning methane (relative to sulfurous coal, for example), which would help to reduce greenhouse gas

emissions worldwide. In addition, if investigations into storing CO_2 in depleted hydrate reservoirs prove promising, there may be further reductions in emissions. The new drilling, production, and geophysical technologies tested in this project are significant and may lead to new industrial development.

A better understanding of gas hydrates will also help in assessing potential impacts of their release on future climate change and in developing techniques to avoid or mitigate hazardous conditions posed by gas hydrates to drilling and pipeline construction. This fundamental research may ultimately have a significant impact on national energy policies.

Technical Data

Technologies used in the project include Vertical Seismic Profiling (VSP), crosshole tomography, conventional two- and three-dimensional seismic surveying, newly developed logging techniques, mass spectrometry, and distributed optical fiber temperature sensing (DTS).

Technology Transfer Potential

Approximately 20% of the land area in the Northern Hemisphere is underlain by permafrost. Consortium members participating in the Mallik project from Germany, Japan, India, the United States, and Canada will be able to share with neighboring countries the information on improved technologies for drilling and production. Scientists will be better prepared to tailor the technology and production information to regional and local conditions and will help address the energy concerns that have a direct effect on the economy and development of these regions.

Participants and Roles

Key research and funding partners include the USDOE, JNOC, GFZ, GSC, MOPNG, and ICDP.

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